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RIVER IMPROVEMENT.

The Improvement of Rivers. A Treatise on the Methods Employed for Improving Streams for Open Navigation, and for Navigation by means of Locks and Dams. By B. F. Thomas and D. A. Watt, U.S. Assistant Engineers, Members Am. Soc. C.E. Pp. xiv+356. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 25*s.* 6*d.* net.

IN their preface the authors state that they know of no recent book which treats of the improvement of rivers except in a general way, possibly because they seem not to be aware of the existence of a book, "Tidal Rivers," published in 1893, and have not apparently heard of the issue of a second edition in 1896, rewritten and enlarged, of "Rivers and Canals," from the first edition of which, published in 1882, they quote a long extract on the principles which should govern the improvement of tidal rivers. Undoubtedly, if the authors of these two books had confined their attention to the rivers of the United Kingdom, there would have been little matter in them properly applicable to American practice, owing to great differences in the physical conditions of the two countries; but both these books range over a very wide field, and deal with the improvement of rivers in various parts of the world, including, of course, rivers in the United States. Though, however, there is not such a complete dearth of books describing the methods of improvement of rivers with extensive basins, as the authors intimate in their preface, and on account of which they express the hope that their book will supply a much needed want, it is certain that the detailed descriptions of American methods and experience relating to the regulation and canalisation of large non-tidal rivers, will be of great service, not merely to those engaged in such works in the United States, but also to all engineers who have to deal with large problems of river improvement in countries containing vast drainage-areas, as met with in eastern Europe, Asia, Africa, and Australia, as well as in North and South America.

The largest river-basin of the United Kingdom, that of the Thames, with an area of only 5244 square miles, owing to the comparatively restricted extent of the British Isles, sinks into insignificance when compared with the Mississippi, having the largest drainage-area of the rivers of North America, amounting to 1,244,000 square miles, which, in its turn, is exceeded by two river-basins in South America, namely, the La Plata with a basin of 1,600,000 square miles, and the Amazon with a basin of about 2,250,000 square miles, the largest in the world. Accordingly, there is little scope in the United Kingdom for regulation works, and even for canalisation, which have enabled inland navigation to be considerably improved and extended along the large rivers of North America. On the other hand, there have not been the same opportunities in America for the great increase in depth of small tidal rivers, by dredging and training works, affording access to seaports, as has been effected in Great Britain in the Tyne, the Clyde, and the Tees, though access for sea-going vessels has been extended from Quebec to Montreal by dredging in the St. Lawrence; whilst the most important works carried out in the United States at the outlet of a river, are the parallel jetties which were constructed several years ago in extension of the South Pass of the tideless and deltaic Mississippi, across the bar encumbering its mouth, in order to concentrate the scour over the bar and thus deepen the outlet channel.

The authors deal very briefly with the improvement of river outlets in a single chapter of only ten pages, stating that this important subject would require a volume; and after quoting at full length the principles laid down by an English engineer for the improvement of tidal and non-tidal river outlets, and alluding to the experiments with working models, carried out by the same engineer, on the effects of training works in tidal estuaries, they refer to the method of improvement by jetties, and conclude with a short account of the jetty works completed at the outlet of the South Pass in 1879, and those authorised last year for obtaining a navigable depth of 35 feet at the outlet of the South-West Pass of the Mississippi. The book, accordingly, really relates to the improvement of the inland portions of large rivers for navigation by regulation works or canalisation, in which the authors, as assistant engineers in the Government Department of the United States, which has control of all the rivers, have wide practical experience, and for which the book furnishes a very valuable guide. This large quarto volume, with 349 pages of text, and illustrated by numerous pages of drawings, diagrams, and photographic reproductions dispersed throughout the book, and eighteen plates of detailed drawings at the end, together with a few blocks in the text, deals with the improvement of rivers in three distinct parts; the general characteristics of rivers and their surveys being considered in the first part, the improvement of open rivers in the second part, and the improvement of rivers by canalisation in the third part.

The first part is divided into five short chapters, occupying only forty pages altogether, treating respectively of introductory matters, the characteristics of rivers, preliminary examinations and surveys, topographical surveys and levelling, and hydrographic surveys. This part is mainly concerned with the preliminary data which require to be obtained before undertaking works of improvement, namely, the physical features of the river, consisting of the amount of the rainfall and the size of the river-basin, the fall and nature of the river-bed, the sediment brought down, shoals, bars, and changes in water-level; next, surveys of the course of the river; and, lastly, cross-sections of the channel, and measurements of the discharges over weirs and in the unimpeded channel.

The second part is divided into seven chapters, and covers ninety-one pages, dealing successively with the "Removal of Bars and other Obstructions," "Regularisation," "Dykes and their Effects," "Protection of Banks," "Levees," "Storage Reservoirs," and "Improvement of River Outlets." The first of these chapters relates to the various devices attempted for stirring up the materials of bars and shoals so as to effect their removal by the current, the different types of dredgers and their capabilities, and the clearing away of trunks of trees, termed snags, and wrecks from the navigable channel. The most interesting work in this respect is the formation each year, during the low stage of the Mississippi, of a channel for navigation, about 250 feet wide and 9 feet deep, across sandy shoals in certain places by suction dredgers, the efficiency of which is increased by stirring up the sand with water-jets; and in 1899 five of these dredgers cut about 62 miles of channel at the average rate of 105 lineal feet per hour. The second chapter of this part lays down the general principles on which the regulation of river channels is based, with the object of obtaining greater uniformity of depth; whilst the following chapter describes the construction of spur and longitudinal dykes, which are sometimes submerged, by which the regulation is effected, a system which has been successfully applied to several of the larger rivers of Europe, as well as in America.

The protection of banks aims mainly at the prevention of prejudicial changes in the course of a river by the erosion of the concave banks in flood-time; and it is accomplished by pitching, rubble stone, fascines, brush mattresses, or occasionally submerged spurs. Levees, consisting of earthen embankments, formed along the banks of a river to prevent the river from inundating the riparian lands in flood-time, are rather works for the protection of property than for river improvement; but to effect their purpose they must be watertight, continuous, and have their tops above the highest floods, which necessarily have their water-level raised by being confined within the banks. Several rivers in Europe have been controlled by embankments, notably the Po, the Loire, and the Theiss; and levees have been extensively carried out on the Mississippi below Cairo and some of its tributaries, the total expenditure on these works in the United States being estimated at about 10,000,000*l*., up to the present time, for a length of 1436 miles; whilst considerable additions to the Mississippi levees are projected. These embankments, however, are liable to be occasionally overtopped and breached by an exceptional flood; and in alluvial plains, as in the case of the Mississippi, they are exposed to undermining by changes in the course of the river, in spite of regulating works; and the rush of water through the gap formed in the bank produces considerable devastation over the adjacent low-lying lands. Rivers bringing along large quantities of detritus in their torrential flow down steep mountain slopes, and abruptly emerging into flat plains, are liable to raise their beds by the deposit of sediment, owing to loss of velocity, when confined within embankments, a result which occurs in the Yellow River of China and some Japanese rivers; and under such conditions, when the embankments are successively raised to compensate for the rising of the river-bed, a terrible catastrophe is a mere question of time, due to the precipitation of the raised and imprisoned river through a weak place in the embankments, with irresistible force and rapidity, into the plains below.

The chapter on "Storage Reservoirs" consists almost entirely of extracts from a report by Captain Chittenden on "Reservoir Sites in Wyoming and Colorado," a method of compilation employed in several of the earlier chapters, though to a minor extent, and also in the following chapter on river outlets, already referred to. Reservoirs would be valuable in river valleys in serving, like lakes, for regulating the flow of rivers by reducing the flood discharge and augmenting the low-water flow. It is, however, only under exceptional conditions that reservoirs can be formed extensive enough, at a reasonable cost, to increase materially the flow of a river at its low stage; but this has been accomplished by damming the outlets of some lakes near the sources of the Volga and Msta in Russia, extending the navigable period of those rivers by nearly three months; whilst a similar improvement has been effected in the Upper Mississippi by raising the water-level of several lakes near the head-waters of the river, a system which might be considerably extended in this case, owing to the immense number of lakes existing near its sources. The formation of reservoirs at intervals along a river valley would greatly reduce the flood discharge by impounding the flood-waters, but the conditions are rarely favourable; and the cost of construction and the extent of land submerged, present insuperable obstacles to the adoption of this system, merely for the mitigation of floods, in the great majority of cases. Several reservoirs, however, have been constructed in Europe for storing up water for water-power for industrial purposes, as well as for the mitigation of floods, with successful results, as, for instance, the Furens and Ternay reservoirs in France, and the Dahlhausen reservoir on the Wappen in Germany, the provision for floods being effected by keeping the reservoir drawn down to a definite extent below its full water-level for their reception.

The third part, relating to the canalisation of rivers, occupies one hundred and forty-one pages, or rather more than half the regular text of the book, and is divided into ten chapters, the three first dealing with locks and lock gates, the fourth with fixed dams on rivers, and the remainder with the various types of movable weirs, which constitute the more novel and most interesting portion of the subject. Though the first movable weir appears to have been the bear-trap weir erected in 1818 across the Lehigh River in the United States, consisting of two gates or shutters turning on horizontal axes on the sill, and one resting on the edge of the other, the principal types of movable weirs were gradually introduced in France between 1834 and 1885; and most of these French forms have been reproduced, on a larger scale, on some of the rivers of the United States; whilst the American bear-trap weir was adopted, with improvements, at Laneuville-au-Pont on the River Marne, in France, about the middle of the nineteenth century.

The object of these movable weirs is to leave the channel of a river quite unimpeded in flood-time for the passage of the flood discharge, and occasionally of vessels when the lock is submerged, whilst retaining the water-level of the river above it at a sufficient height for navigation in dry weather; and the three chief French types are the Needle Weir, the

Chanoine Shutter Weir, and the Drum Weir. The needle weir consists of a series of wooden spars resting against a bar at the top across the weir, carried on a row of iron frames providing a foot-bridge, and against a sill at the bottom, though of late years sliding panels or rolling-up curtains have been often substituted for the spars or needles; and this type of weir has been adopted for the first time in the United States for a weir across the Big Sandy River at Louisa, in Kentucky, with large inverted V-shaped frames placed 8 feet apart, and lying one inside the other when lowered on the apron in flood-time, and closed by needles having the exceptional dimensions of 12 inches width, 14 feet length, and 8½ inches thickness at the bottom and 4½ inches at the top, which are handled by a floating derrick. The frame weir suspended from an overhead bridge, so that all the movable parts can be raised out of the river in flood-time, as resorted to on the Lower Seine at Poses and Port-Mort, and the barriers substituted for needles, are described and illustrated in the book, but have not hitherto been adopted in the United States.

The Chanoine shutter weir is composed of a series of shutters supported centrally on a trestle, and turning on a horizontal axis, the trestle being maintained in an upright position by a prop, resting at its lower extremity in a cast-iron shoe fixed to the apron when the river is closed; and the weir is opened by withdrawing the props from their shoes, causing the trestles to fall flat on the apron, with the shutters on top of them in a horizontal position. Owing to the rapidity with which it can be opened, this type of weir is advantageous for rivers subject to sudden floods; and it has been adopted in the United States across the deep navigable passes on the Ohio and Kanawha Rivers, where shutters somewhat larger than the biggest in France have been erected.

The drum weir consists essentially of an upper and an under paddle revolving on a central horizontal axis, the row of upper paddles forming the weir; and the under paddles, revolving in the quadrant of a horizontal cylinder forming the drum, are made to close or open the weir by altering the water-pressure on their two sides in the drum, so that when the head of water from the upper pool presses on the upstream side of the under paddles, the upper paddles rise against the current of the river. In spite of the perfect control of this weir which the under paddles afford, the deep foundations required for these paddles below the sill, exceeding the height of the weir above it, have hindered its general adoption; and since the completion, in 1867, of a series of these weirs in the canalisation of the Marne, a tributary of the Seine, they have only been used in Europe for timber passes at the side of the weirs erected across the River Main for canalising it in 1883–6, and across the navigable pass, 9 feet in depth, of the Spree at Charlottenburg. A modified form of drum weir has been quite recently constructed in timber across the Osage River in Missouri, in which the paddles are replaced by a sector of a cylinder which fits exactly in the drum when lowered, and closes the weir when raised. The old bear-trap weir fell into oblivion for many years in America; but within the last few years some weirs of this type, of improved design, have been constructed; and two, placed alongside a new weir near Beaver on the Ohio River, each 120 feet long and 13 feet high, serve for the passage of drift and for regulating the discharge.

Another peculiar, novel type of weir, also forming part of the new weir across the Ohio, consists of a series of A-shaped frames, which, as in other frame weirs, can be lowered flat on the bed of the river in flood-time; but it differs from ordinary frame weirs in the frames themselves forming the barrier for closing the weir, by being constructed with a widened plated upstream leg touching the plates of the legs of the adjacent frames when standing upright, besides furnishing a support for the foot-bridge along the top of the weir.

The book concludes with three appendices, giving the dimensions of various locks and weirs in the United States, the standard specifications adopted for certain river works and materials, and laws for protecting the waterways in the United States. Altogether, the book affords a large amount of information about works carried out on rivers under Government in the United States; whilst in some of the chapters, such as those on levees, storage reservoirs, and more especially those on movable weirs, interesting particulars are also given of European works.

THE FISHERMAN IN AMERICA.

Bass, Pike, Perch, and Others. By James A. Henshall. Pp. xix+410. (New York: the Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 8*s*. 6*d*. net.

Big Game Fishes of the United States. By Chas. F. Holder. Pp. xiv+435. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 8*s*. 6*d*. net.

THESE two volumes of the "American Sportsman's Library" deal with the fishes of the United States, other than salmon, trout, and char, from the sportsman's point of view. Although the same ground is to a certain extent covered by both, Dr. Henshall has to deal with numerous species inhabiting both fresh and salt water, while Mr. Holder's volume confines itself to a comparatively small number of marine species, and this naturally results in the adoption of a different method of treating the subject by the two authors; this much they have in common, that both have produced books which give the angler information as to the tackle to be employed for each species and the places in which to employ it, and at the same time illustrate their remarks with excellent personal observations on the habits of the fish with which they deal.

The first book under notice combines in a greater degree than almost any other work of which we are aware, systematic ichthyology and directions to the fisherman; the author has adopted the classification of Jordan and Evermann's "Fishes of North and Middle America," and his specific descriptions and most of his nomenclature are taken from that standard work, with the addition of useful observations of his own upon the